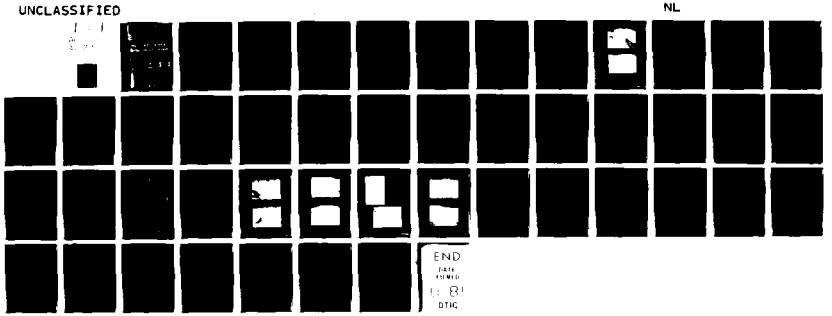
AD-A103 711 ARMY ENGINEER DISTRICT NORFOLK VA F/G 13/13
NATIONAL DAM SAFETY PROGRAM. WARRENTON DAM (INVENTORY NUMBER VA--ETC(U)
MAR 81 B O TAKAN

UNCLASSIFIED NL



POTOMAC RIVER BASIN

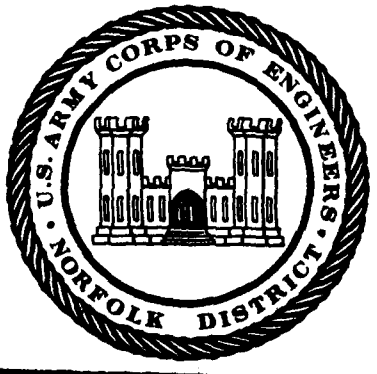
LEVEL II

RS

e Of Dam: WARRENTON
tion: FAUQUIER COUNTY, VIRGINIA
tory Number: VA 06101

AD A103211

HASE I INSPECTION REPORT
TIONAL DAM SAFETY PROGRAM



PREPARED BY
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

MARCH 1981

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FO

1. REPORT NUMBER: VA 06101	2. GOVT ACCESSION NO.: AD-A103 711
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE *(and Subtitle)*: Phase I Inspection Report National Dam Safety Program Warrenton, Fauquier County, VA	5. TYPE OF REPORT & PERIOD COV: Final
	6. PERFORMING ORG. REPORT NUMB:
7. AUTHOR(s): Norfolk District, Boris O. Taran	8. CONTRACT OR GRANT NUMBER(s): Norfolk District
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U. S. Army Engineer District, Norfolk 803 Front Street Norfolk, Virginia 23510	10. PROGRAM ELEMENT, PROJECT, TA: AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS:	12. REPORT DATE: March 1981
	13. NUMBER OF PAGES:
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*:	15. SECURITY CLASS. *(of this report)*: Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service,
Springfield, Virginia 22151

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Dams - VA
National Dam Safety Program Phase I
Dam Safety
Dam Inspection

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

(See reverse side)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Inspection is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the gereral conditions of the dam is based upon available data and visual inspection. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to idenify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

POTOMAC RIVER BASIN

NAME OF DAM: WARRENTON DAM
LOCATION: FAUQUIER COUNTY, VIRGINIA
INVENTORY NUMBER: VA 16101

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Warrenton Dam (Inventory Number VA 06101), Potomac River Basin, Fauquier County, Virginia. Phase I Inspection Report.

(10) Boris O. /Taran

PREPARED BY
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

11 MAR 1981

(12) 47

411 030

TABLE OF CONTENTS

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

BRIEF ASSESSMENT OF DAM

Name of Dam:	Warrenton Dam
State:	Virginia
Location:	Fauquier County
USGS Quad Sheet:	Warrenton, Virginia
Stream:	Cedar Run
Date of Inspection:	18 March 1981

Warrenton Dam is comprised of a 550 foot long concrete slab and buttress dam and two earthen dikes separated by a grassy knoll. The dikes are in the reservoir located in a low lying area north of the dam. One dike is about 300 feet long and 13 feet high. The other dike, perpendicular to the first, is about 175 feet long and 6 feet high. A concrete intake structure comprised of three 8-inch intakes at different elevations allows flow to discharge into the stream below the dam, furnishing water to the Warrenton Filtration Plant about 2 miles downstream. The concrete intake structure also has a 24-inch inlet and a 24-inch outlet. The maximum height is 30.8 feet for the concrete spillway. The dam is located 0.5 miles north of the Warrenton town limits and is used as the water supply for Warrenton, Virginia. The dam is owned and maintained by the Town of Warrenton, Virginia. The dam is classified as a small dam with a significant hazard classification.

Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) is the 100 year flood. Since the spillway was sized for the 21 percent PMF, which is greater than the 100 year flood, the spillway is adjudged as adequate.

The dam is in excellent condition with only one significant exception cracks and seeps were observed at buttress "A" beginning at the crest of the original 1966 dam and extending down about 2.5 feet parallel to the slab face. The dam and appurtenances are in the final stages of construction and a number of the following recommendations may be a part of the contractors obligations.

It is recommended that the owner take the following actions:

a. Monitor cracks and seeps at buttress "A" by maintaining a photographic record.

b. Consider repairing the expansion joint at slab G-H to reduce leakage.

c. Extend riprap on the upstream dike slopes to protect the abutments contacts.

d. Reseed dikes.

e. Develop an emergency operation and warning plan.

f. Monitor flow in the small spring at the right abutment.

Submitted By:

Original signed by:
Carl S. Anderson, Jr.

for JAMES A. WALSH, P. E.
Chief, Design Branch

Approved:

Original signed by:
Douglas L. Haller

DOUGLAS L. HALLER
Colonel Corps of Engineers
District Engineer

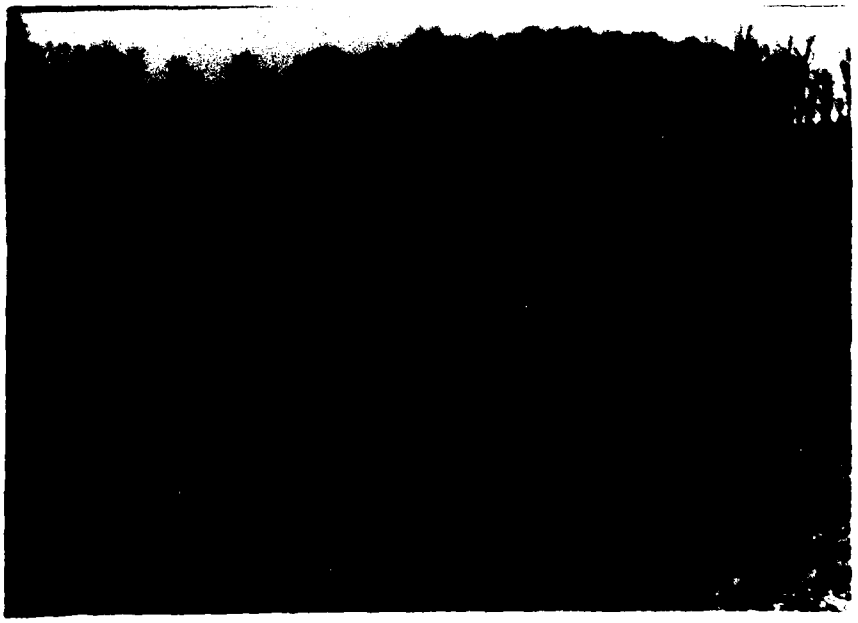
Date: JUL 6 1981

Recommended By

Original signed by
JACK G. STARR

JACK G. STARR
Chief, Engineering Division

GRAVITY DAM



DIKE SYSTEM

OVERALL VIEWS WARRENTON DAM

18 MARCH 1981

SECTION 1

PROJECT INFORMATION

1.1 GENERAL:

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to initiate a National Program of Safety Inspections of Dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1, Appendix IV). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances:

1.2.1.1 Concrete Dam: The dam is a 550 foot long reinforced concrete structure consisting of 2 foot thick slabs spanning continuously across buttresses. The maximum height above stream bed is 30.8 feet, however, buttresses were extended well below grade to key into competant rock. Buttress spacing varies from 21'-0" to 40'-0".

The crest of the spillway, consisting of a 1.0 foot notch in the dam is 74 feet long (elevation 445.3) located near the right abutment. Water flowing over the dam at this location falls into a riprapped plunge pool. The crest steps upward 1.0 feet to left of the spillway and extends 192 feet toward the left abutment before stepping up again to the left wingwall which serves as the crest of the dam. To the right of the spillway the dam also steps upward 1.0 feet extending 32 feet toward the right abutment before stepping upward again to the dam crest.

1.2.1.2 Earth Dikes: There are two dikes in the reservoir located in a low lying area north of the dam. The dikes elevate the minimum reservoir rim to provide a 9 foot freeboard.

The dikes are about 160 feet due north of the dam. One dike is approximately 300 feet long, 13 feet high, and is oriented in a southeast to northwest direction. The second dike is approximately 175 feet long and 6 feet high. It abuts and is perpendicular to the left abutment of the first dike forming an L shape alignment. It is oriented in a southwest to northeast direction.

Both dikes are approximately 11 feet wide with 3H:1V riprapped upstream slopes and 2.5H:1V downstream slopes. The riprap consists of a VDH & T Class I, size 50-150, 12-inch thick armor with a No. 21 stone, 6-inch thick bedding. The dikes are keyed with a minimum 10 foot wide trench. The 300 foot dike has an embankment toe drain filter and a stone toe drain. The filter is a VDH & T grading "A" fine aggregate. The toe drain is a coarse aggregate No. 357. The crest and slopes of both dikes are vegetated with grass.

1.2.2 Location: Warrenton Dam is located about 0.5 miles north of the Warrenton town limits on Cedar Run in Fauquier County, Virginia.

1.2.3 Size Classification: The dam is classified as a small dam as defined by Reference 1 of Appendix IV.

1.2.4 Hazard Classification: The dam is located upstream of a filtration plant and gravel road and a major U. S. Highway. One residence is located below the dikes. Therefore, a significant hazard classification is given for the Warrenton Dam according to guidelines contained in Section 2.1.1 of Reference 1, Appendix IV. The hazard classification used to categorize dams is a function of location only and has nothing to do with their stability or probability of failure.

1.2.5 Ownership: Town of Warrenton, Virginia.

1.2.6 Purpose: Water Supply for Warrenton, Virginia.

1.2.7 Design and Construction History: The original dam was constructed in 1966 by Howell Construction Company. The crest was raised four feet in 1981. Design for both the original dam and the crest extension was performed by Hayes, Seay, Mattern and Mattern.

1.2.8 Normal Operational Procedures: Water flows over the spillway automatically when the reservoir rises above elevation 445.3. Water is regulated through the multiple level intake structure to supply water to the Warrenton Filtration Plant when the water level is below elevation 445.3.

1.3 Pertinent Data:

1.3.1 Drainage Area: The dam controls a drainage area of 11.72 square miles.

1.3.2 Discharge at Dam Site: The maximum flood occurred in June 1972 when the stream gage 400 feet below the dam recorded a flow of 7840 cfs.

Pool level at crest of spillway (top of concrete - elevation 449.3)

Spillway . . . . . 5795 cfs

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Reservoir Elevation feet msl	Capacity Acre,* feet
Crest of Dike	454.5	937
Crest of Spillway	449.3	236
Normal Pool	445.3	61
Streambed at Downstream toe of Dam	418.5	-

*Available storage above elevation 445.0.

SECTION 2

ENGINEERING DATA

2.1 Design and Construction Records:

2.1.1 Concrete Dam: The major design document for this structure is the "Final Design Report Town of Warrenton, Virginia Dam, Extension and Reservoir Expansion" by Hayes, Seay, Mattern and Mattern (HSMM) dated April 1980. A complete structural analysis of the existing 1966 structure is included in the HSMM report as well as design notes for the four foot crest extension built in 1980. The design flood for structural design was the 1/2 PMF. Hydrologic and hydraulic design for the dam is also included in the HSMM report.

In September 1964 and January 1965, Cunningham Core Drilling and Grouting Coporation drilled 16 test borings for the project. Nine borings, designated 1 through 9, were drilled along the dam alignment. Material encountered as noted on the boring logs consisted of mica schist and actinolite gneiss. Core recoveries were generally low at the surface, ranging from 0% to 99% and increased with depth with recovery valves between 22% to 99%.

The foundation of the dam was drilled and grouted to develop a grout curtain. Grout holes were drilled to depths of 20 to 35 feet. Test data such as pressure testing after the development of the grout curtain is not available to determine the effectiveness of the grout curtain. Information in the report by Hayes, Seay, Mattern and Mattern (April 1980) indicates that total grout consumption was low which suggest that the foundation is sound.

The only construction record available for this inspection was a list of concrete cylinder 28 day breaks for the original dam included in the Hayes, Seay, Mattern and Mattern design report.

As built drawings were not available for the original dam or the project to increase the crest height. However, original design drawings for the crest extension project were available for review. These drawings are on file at the designer's office.

A report on a previous inspection of the dam on 8 and 9 May 1979 is included in the Hayes, Seay, Mattern and Mattern design report. This inspection indicated that the dam was in excellent condition at the time of inspection. Only minor spalling and one crack was observed at buttress A.

2.1.2 Dikes: There are two dikes, as previously described; one 300 feet long and the other 175 feet long. The 300 foot dike was built over an existing dike. Plan views and cross sections of the dikes are shown on Plates 3 and 2, respectively.

Explorations were performed to determine the condition and strength of the existing dikes, to investigate the location for the new dike, and to evaluate a proposed borrow area in the immediate downstream area. Seven borings were drilled in this area. Borings 10, 11 and 12 were drilled in the area of the 300 foot dike. Boring 11 was drilled into the existing dike. Borings 13 and 14 were located in the area of the new dike. Borings 15 and 16 were located in the borrow area in the immediate downstream area.

No laboratory analyses were performed. Data were based on typical values of compacted soils presented in NAVFAC DM-7, Soil Mechanics, Foundations, and Earth Structures.

Design calculations are provided in Appendix C of the Final Design Report. Design analyses are limited to the 300-foot dike.

The dikes were designed according to guidelines provided in Earth and Earth-Rock Dams by Sherard. Slope stability analyses were calculated using the Bishop Modified Method and the Ordinary Method of Slices. The upstream slope was checked for rapid drawdown, and the downstream slope for steady seepage. Seismic analyses were performed according to the U. S. Army Corps of Engineers, EM 1110-2-1902. Seepage analyses, and filter and toe drains designs were determined according to Foundation, Design, and Practice by E. E. Seelye.

There are no contract specifications or construction records available for review concerning dike construction.

2.2 Evaluation: Available information is adequate to evaluate the overall stability of the concrete dam and earth structures. Specific details of the concrete slab and buttress connection at buttress "A" where cracks are occuring in the original buttress were not available.

SECTION 3

VISUAL INSPECTION

3.1 Findings:

3.1.1 General: The results of the 18 March 1981 inspection are recorded in Appendix III. It was snowing during the inspection and the temperature was 30-35°. At the time of the inspection the pool elevation was approximately 445.0, 0.3 feet below the crest of the principal spillway.

3.1.2 Concrete Dam: With a few exceptions the dam is in excellent condition.

Buttress "A" is cracked at the underside of the thickened edge of the original dam crest and buttress junction (see Photo #5). Cracks extend approximately 2.5 feet down the buttress parallel to the slab face. Water is seeping out of the cracks and the buttress in this vicinity is wet.

A 2 foot ± long vertical crack is located at the centerline of slab L-M extending down from the old crest of the dam. No seepage was observed at this crack. Minor surface cracking was observed.

Seepage is occurring at buttresses C, D, and at slabs L-M, M-N, and N-P at the slab/buttress contact. The expansion joint at slab C-D is slightly damp but not dripping. At slab K-L water is dripping along the new contact with the old crest where the crest was raised. The expansion joint at slab G-H is leaking approximately 7-10 gpm. (see Photo #6). The owner has indicated by correspondence that this seepage was observed prior to the caulking of the construction joints by a contractor.

3.1.3 Foundation and Abutements: Warrenton Dam and reservoir are located in the Piedmont physiographic province of North-Central Virginia. Rock that underlie and outcrop in the dam area consist of diabase, gneiss, mica schist, green schist, horneblende and chlorides. Furcron (1939) identified these rocks as belonging to the Catoctin series and Fauquier formation, both of Precambrian age. Overburden in the area consisted of a red silty fine sand loam. The schist is oxydizing to produce a rusty appearance.

Since the dam is located on rock no vertical displacement of the dam would be expected and no indication of movement was observed.

Standing water was present from buttress C to buttress E, the size of the pool was approximately 80 feet long and 20 feet wide with a depth of 1 foot. A soft marshy area extended from buttress C to buttress J. The source of water for these wet areas is believed to be coming from leakage through expansion joints in the dam and seepage around and under the cutoff wall.

Leakage through and around the cutoff wall is small and is not expected to effect the integrity of the dam.

The left and right abutments show no deterioration or erosion. Slight to no weathering of exposed rock was observed. A small spring was observed in the right abutment approximately 20 feet downstream. Flow was visually estimated at less than one gallon per minute.

3.1.4 Dikes: There are no signs of settlement, movement, sloughing, erosion, or misalignment. There are cracks in the crest of both dikes. However, the cracks are less than an inch deep and are due to frozen conditions. There are no riprap failures. The upstream slopes of each dike are protected with a diabase stone up to two feet in size. Abutment contacts are not riprapped. The dikes were vegetated with grass during recent construction. Certain areas are sparse.

3.1.5 Outlet Works: The outlet works consist of a concrete intake structure with three 8-inch valves at different elevations that service a 24-inch outlet running through the dam. The valves are regulated to pass water to the Warrenton Filtration Plant downstream of the dam. The visible portion of the intake structure appeared to be in excellent condition. The outlet pipe is submerged.

3.1.6 Spillway: The spillway is a concrete weir 74 feet in length at elevation 445.3, 224 feet in length at elevation 446.3, and 187 feet in length at elevation 449.3. The concrete appears to be in good condition.

3.1.7 Instrumentation: There is no instrumentation on the dam.

3.1.8 Reservoir Area: The slopes are gentle with grass pastures and wooded areas. No erosion was observed around the reservoir. There is very little development in the watershed.

3.1.9 Downstream Channel: The downstream channel is riprapped and in fair condition with little debris. The flow over the weir is not channeled but will flow into Cedar Run. The downstream area is gently sloped. One home is located below the dikes and the Warrenton Filtration Plant is located about two miles downstream of the dam.

3.2.1 Concrete Dam: Cracks at buttress "A" have apparently significantly worsened since the 8 and 9 May 1979 inspection by Hayes, Seay, Mattern and Mattern. The previous 8 and 9 May inspection listed only one crack and minor spalling at this location with no mention of seepage.

Except for the above mentioned buttress cracking, the concrete structure portion of Warrenton Dam is in excellent condition.

The leakage through and around the cutoff walls, and the spring are not expected to effect the integrity of the dam. Flow from the spring should be monitored after lengthy periods of rain and when the reservoir is at different levels. This should aid in determining if the reservoir is contributing flow to the spring.

A staffgage should be installed to extend above the top of the dam to measure reservoir levels above normal pool.

3.2.2 Dikes: Upstream slope riprap should be extended to protect the abutment contacts from erosion due to runoff and/or wave action. Dikes should be reseeded in the spring to provided cover for sparse areas.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures: The normal storage pool is 445.3, which is the lower crest of the spillway. The reservoir provides water supply for the Town of Warrenton, Virginia. Water is regulated through 8-inch gates valves at elevations 426.0, 431.0 and 436.0 in the intake structure. When the reservoir rises above elevation 445.3, water will automatically flow over the concrete weir spillway. The reservoir can be lowered by operating the 24-inch sluice gate with an invert elevation of 419.

4.2 Maintenance: Maintenance of the dam and reservoir is performed as needed by the owner.

4.3 Warning System: At present time, there is no warning system or evacuation plan for Warrenton Dam. The owner has indicated by correspondence that monitoring of the dam on a daily basis has been implenated by Town Personnel and that procedures will be established for daily records.

4.4 Evaluation: The dam does not require an elaborate operational and maintenance procedure. However, the present maintenance program should be documented. An emergency operation and warning plan should be developed. It is recommended that a formal emergency procedure be prepared and furnished to all operating personnel. This should include:

a. How to operate the dam during an emergency.

b. Who to notify, including public officials, in case evacuation from the downstream area is necessary.

SECTION 5

HYDRAULIC/HYDROLOGIC DATA

5.1 Design: The spillway design calculations for the recent extension to the Warrenton Dam, as provided in the "Final Design Report", Town of Warrenton, Virginia, Dam Extension and Reservoir Expansion, by Hayes, Seay, Mattern and Mattern, was available for the inspection and evaluation of the Warrenton Dam.

5.2 Hydrologic Information: A stream gage, 01655500 Cedar Run near Warrenton, Virginia, has been in operation since July 1950. The water-stage recorder is maintained by the Virginia State Water Control Board and is located about 400 feet downstream of the Warrenton Dam, just downstream of a small highway bridge that crosses Cedar Run.

5.3 Flood Experience: The greatest known flood at the dam occurred in June 1972 when approximately 7840 cfs passed over the original dam during Tropical Storm Agnes. There were no records or reports about the performance of the dam during the flood.

5.4 Flood Potential: The 1/2 Probable Maximum Flood and 100-year flood were developed and routed through the reservoir by Hayes, Seay, Mattern and Mattern for the Final Design Report for the extension of Warrenton Dam.

5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1. Normal flows are maintained at elevation 445.3. Excessive flows pass automatically over the spillway crest and flow downstream.

The storage curve and discharge rating curve were computed by hand. Average inflows were passed through the 24-inch low level outlet.

5.6 Overtopping Potential: The probable rise of the reservoir and other pertinent information on reservoir performance are shown in the following table:

Table 5.1 RESERVOIR PERFORMANCE

Item	Normal Flow	100 1/ Year	1/2 PMF 2/
Peak flow c.f.s.			
Inflow	13	4931	13826
Outflow	13	4900	13800
Elevation, ft. msl	445.3	448.94	451.35
Elevation of earthen abutment (449.3)	-	-	-
Depth of flow, ft	-	-	2.05
Average velocity, fps 3/	-	-	4.6
Earthen dike (elevation 454.5)			
Depth of flow, ft	-	-	-
Average velocity, fps	-	-	-
Tailwater elevation ft msl	422±	-	-

1/ The 100-Year Flood has one chance in 100 of occurring in any given year.
2/ The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.
3/ Critical Velocity

5.7 Reservoir Emptying Potential: Three 8-inch intakes at different levels in the reservoir and a 24-inch low level gate service the water intake and allows the reservior to be drawn down in 7 days if necessary from elevation 451.0 as computed by Hayes, Seay, Mattern & Mattern.

5.8 Evaluation: Warrenton Dam is a small size significant hazard dam requiring evaluation for a spillway design flood (SDF) in the range between the 100 year flood and the 1/2 PMF. The design selected by Hayes, Seay, Mattern and Mattern, 21 percent of the PMF, fits into the SDF range. The SDF will reach elevation 449.3, top of concrete spillway, without washing the earthen abutments.

Conclusions pertain to present day conditions and the effect of future development on the hydrology has not been considered.

SECTION 6

DAM STABILITY

6.1 Stability Analysis:

6.1.1 Concrete Dam: The "Final Design Report Town of Warrenton, Virginia Dam Extension and Reservoir Expansion" by Hayes, Seay, Mattern and Mattern (dated April 1980) indicates that the dam is stable for loadings up to and including the 1/2 PMF.

Cracks at buttress "A" have apparently significantly increased since the Hayes, Seay, Mattern and Mattern inspection of 8 and 9 May 1979 when only minor spalling was noted. As built drawings showing the slab to buttress connection of the original dam were not available for preparation of this report, therefore, the significance of these cracks could not be evaluated. The cracking pattern seems to indicate a bearing type failure, but loads near the old dam crest are relatively small. The cause of cracking is unknown and a detailed evaluation to more accurately determine the cause of cracks a buttress "A" is beyond the scope of a Phase I Inspection.

6.1.2 Foundation and Abutments: The dam site is located in the Piedmont physiographic province. The area is underlain by diabase, gneiss, and mica shist belonging to the Catoctin series and Fauquier formation, both of Precambrian Age.

The dam was constructed with a cutoff wall and a grout curtain to depths of 20 to 35 feet.

No evidence of settlement of the dam was noted during the inspection nor is any expected since the dam is founded on bedrock.

Excessive leakage under the dam was not present. The small amount of leakage under the dam should not effect the integrity of the dam. It is not possible to determine if leakage is occuring through or under the grout curtain. Flow is very likely occurring along fractures, joints and schistosity planes in the bedrock.

The right and left abutment are intact and show no abnormal erosion or deterioration.

The foundation is considered stable and relatively impervious.

6.1.3 Dikes: The material is primarily residual micaceous silts and clay overlying highly weathered schist or gneiss. The material is relatively impervious and stable.

The existing earth dike material was reportedly obtained from the reservoir area and placed it ± 2 percent optimum according to AASHO: T-150 (Modified Proctor Test). The predominate material is a clay (CL). Borrow materials for the new dike were taken from the immediate downstream area. The predominate material is silt (ML).

The dikes were constructed with a minimum 10 foot wide keytrench and upstream slope protection. The 300 foot dike was constructed with a filter and stone foundation toe drain.

No laboratory testings was performed. Parameters were based on typical compacted values per NAVFAC DM-7. A VDH&T Grading "A" fine aggregate was used for a filter. Coarse aggregate No. 357 was used for the toe drain.

Slope stability analyses were performed according to the Modified Bishop Method and the Ordinary Method of Slices. A shallow slope failure tangent to the foundation was assumed as the mode of failure. Only calculations for the 300 foot dike were performed.

The following properties were assumed for saturated conditions:

MATERIAL	ϕ	C	γ
CL (Existing Dike)	15°	300 psf	130 pcf
ML (Borrow)	20	200	137
Stone Drain	45	1	140

The existing dikes have a 3H:1V upstream slop with a approximate 11 foot wide crest and a 2.5H:1V downstream slope. The crest elevations are at 454.5. Normal pool is a 445.3.

The upstream slope was checked for sudden drawdown condition from 1/2 PMF and EL 451.35 to 441.3. The downstream slope was checked for a steady seepage condition with the pool at EL 451.35. The dikes were also checked for seismic stability (Zone II) using a horizontal accelerating 0.1g. Two conditions were analysed the first was with a pool level at EL 451.35 and the downstream slope with steady seepage; the second was a condition of drawdown to the normal pool level of elevation 445.3 and steady seepage.

The following is a breakdown of calculated factors safety:

Slope	Drawdown	Steady Seepage	Seismic
Upstream	7.69	-	1.84
Downstream	-	1.89	1.46

These factors are considered greater than the recommended factors in Reference 1, Appendix IV.

6.2 Evaluation:

6.2.1 Concrete Dam: The overall condition of the dam is excellent. No sign of instability was observed, however, cracks at buttress "A" should be inspected frequently for signs of increased cracking or seepage. Cracks do not represent a threat to the safety of the structure at this time. If further cracking occurs or a significant increase in seepage is observed we would recommend that remedial measures be taken.

6.2.2 Dikes: Available design of the existing dikes is considered conservatively adequate. Additional stability checks are not required.

SECTION 7

ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: Corps of Engineer guidelines indicate the appropriate Spillway Design Flood (SDF) for a small size significant hazard dam ranges between the 100 year flood and the 1/2 PMF. Warrenton Dam was designed to pass 21 percent of the PMF without overtopping the dam crest which is greater than the 100 year flood. The spillway is adjudged as adequate.

The inspection revealed no findings which proved the dam to be unsound. Available engineering data was adequate for review. The dam is in excellent condition with only one significant qualification; cracks and seeps were observed at buttress "A" beginning at the crest of the original 1966 dam and extending downward about 2.5 feet parrallel to the slab. Overall, the dam is considered sound. A stability analysis is not required.

Since the dam is in the final stages of construction modifications a regular maintenance program does not exist. There is no emergency operations plan or downstream warning system.

7.2 Recommended Remedial Measures: It is recommended within 12 months the following items be scheduled and implemented by the owner:

7.2.1 Cracking and seepage at buttress "A" should be monitored regularly. A dated photographic record should be maintained so that changes in conditions may be readily observed. The photographic record should be correlated with the pool levels in the reservoir.

7.2.2 Consideration should be given to repair the expansion joint in slab G-H. The estimated leakage of 7 to 10 gallons per minute is excessive when considering the fact that the expansion joints were recently reworked during the dam extension project which is currently nearing completion. (The owner has indicated that this condition existed prior to the recent joint caulking efforts).

7.2.3 Upstream slope riprap on the dike system should be extended to protect the abutment contacts from erosion due to runoff and wave action. Dikes should be reseeded to provide cover for sparse areas.

7.2.4 An emergency operation and warning plan should be developed and furnished to all operating personnel. This should include:

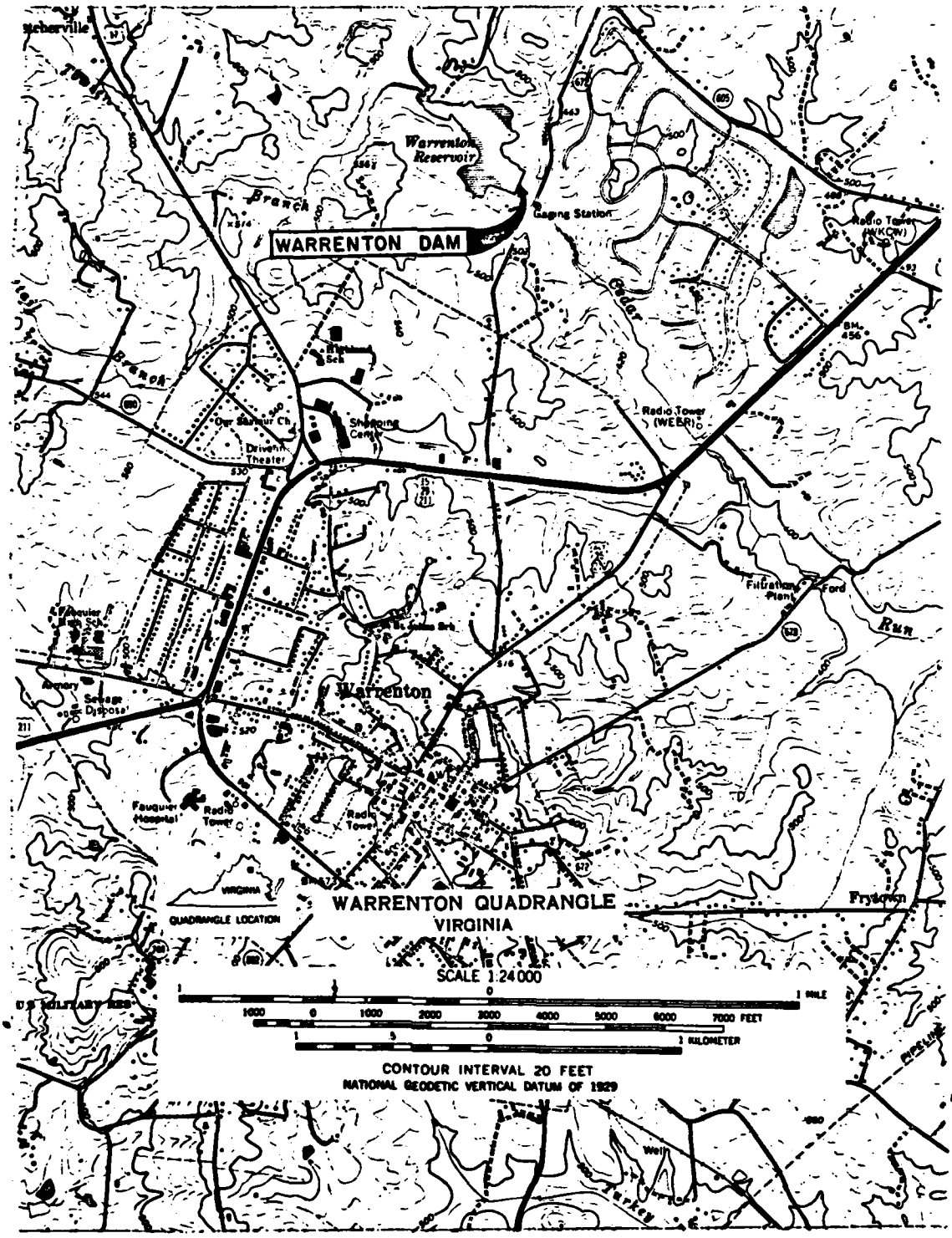
a. How to operate the dam during an emergency.

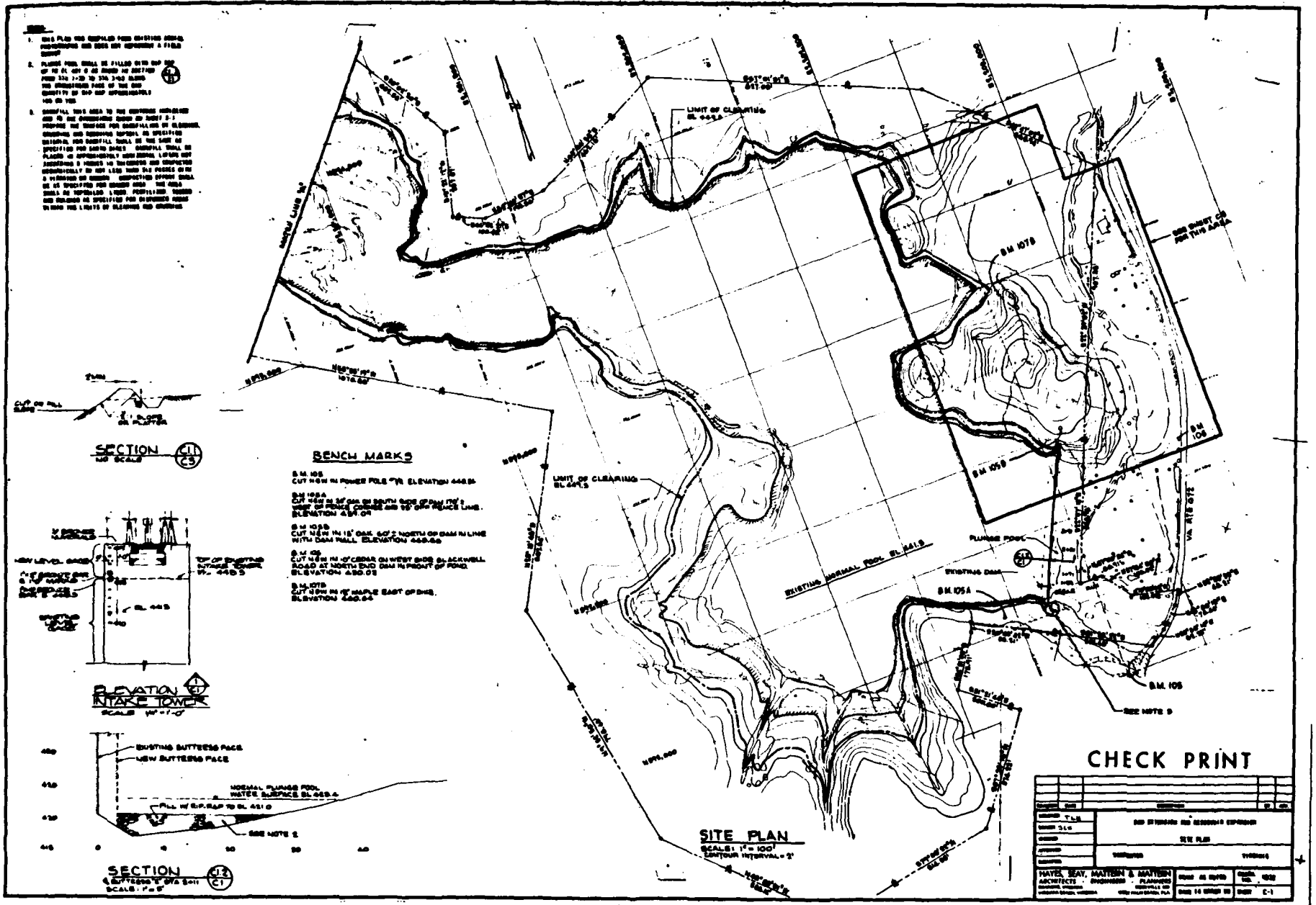
b. Who to notify including public officials, in case evacuation from the downstream area is necessary.

7.2.5 Flow from the small spring in the right abutment should be monitored after lengthy periods of rain. Additionally the spring should be monitored when the reservoir is at different levels. This data should be used to determine if the reservoir is contributing flow to the spring.

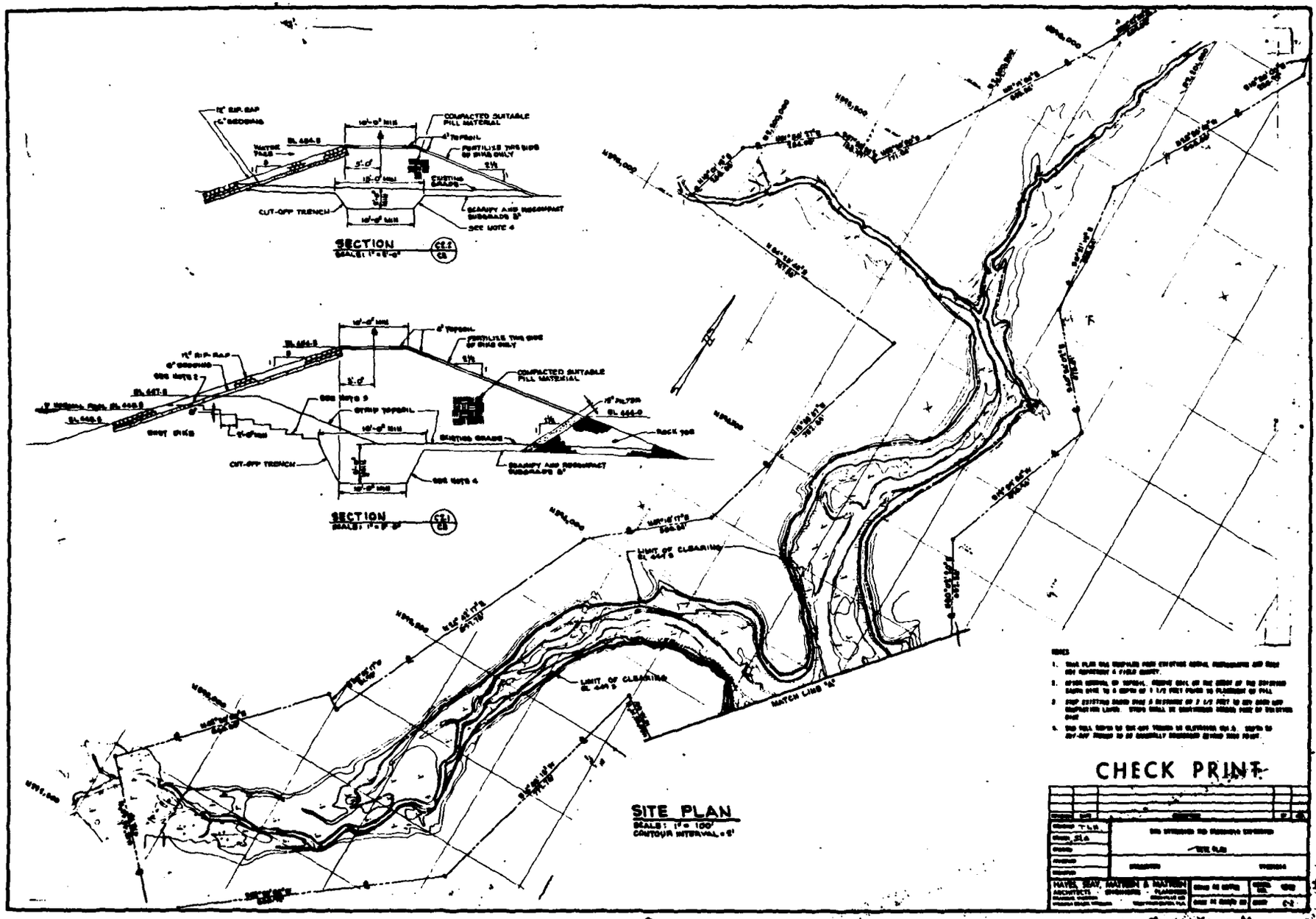
APPENDIX I

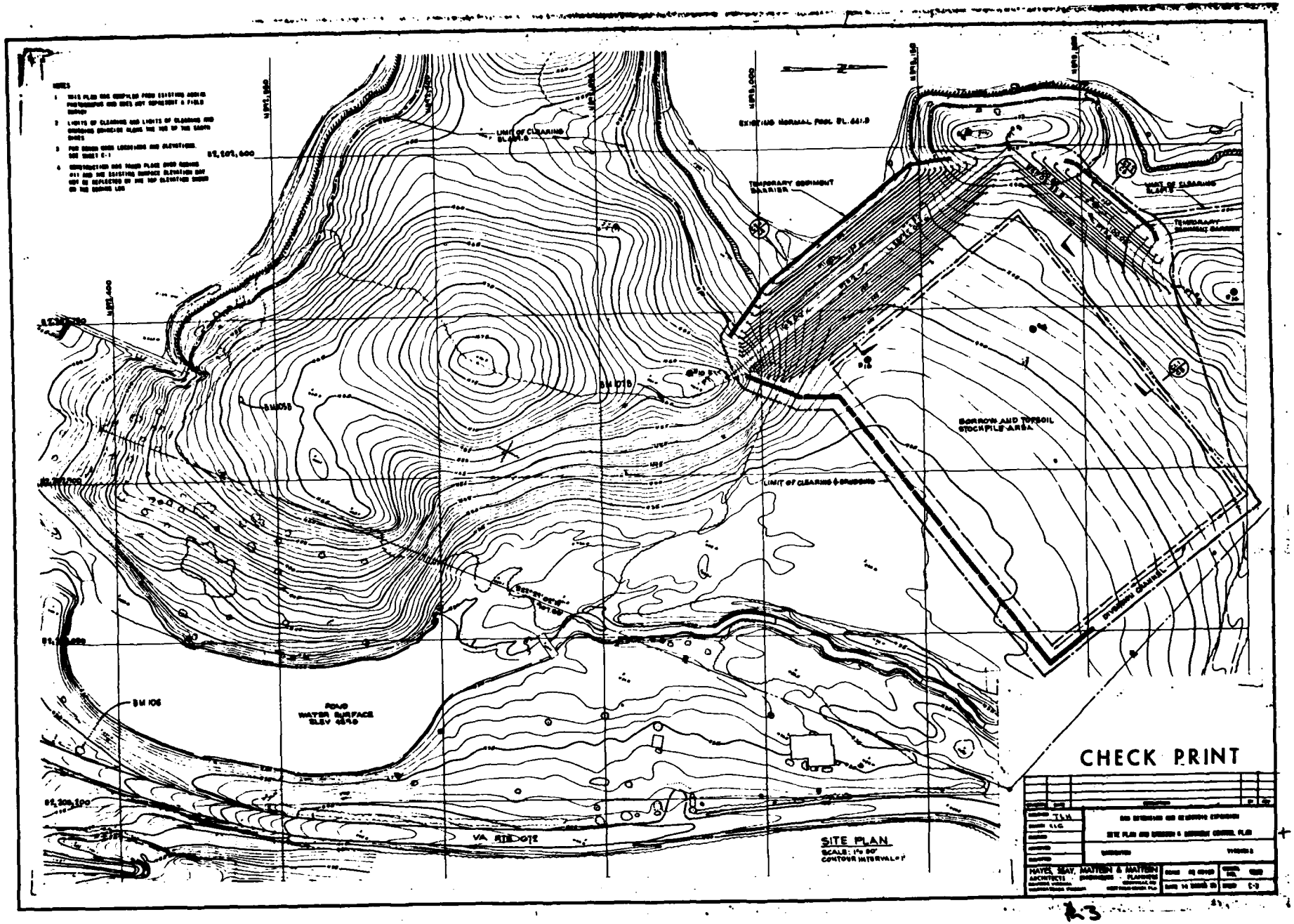
MAPS AND DRAWINGS

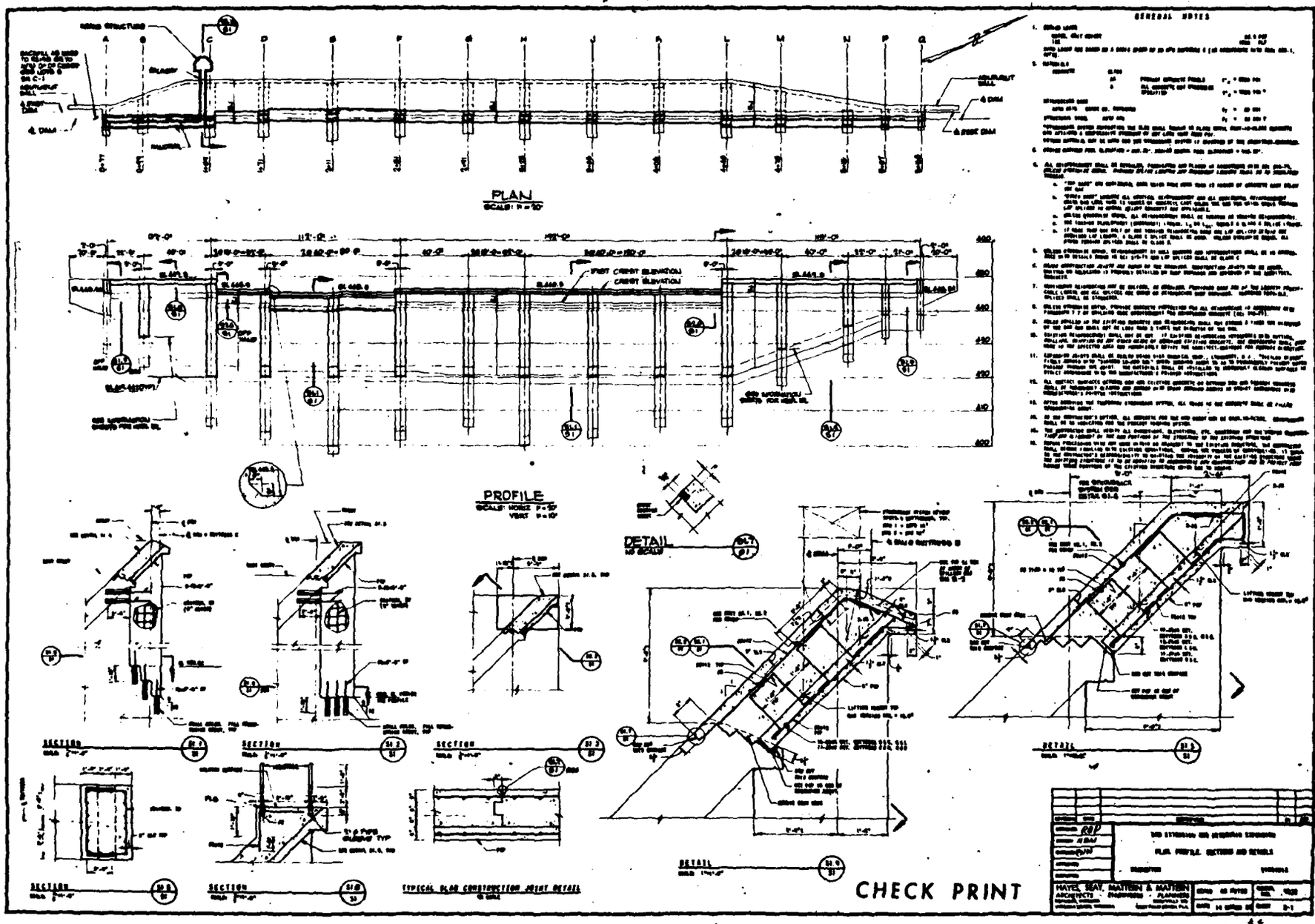

WARRENTON DAM
Warrenton Reservoir
Cedar Run
Warrenton
Fauquier Hospital
Radio Tower (WEER)
Radio Tower (WKCW)
Drive-In Theater
Shopping Center
Filtration Plant
Ford
Fry's Run
Parker
WARRENTON QUADRANGLE
VIRGINIA
SCALE 1:24 000
1 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
QUADRANGLE LOCATION
VIRGINIA

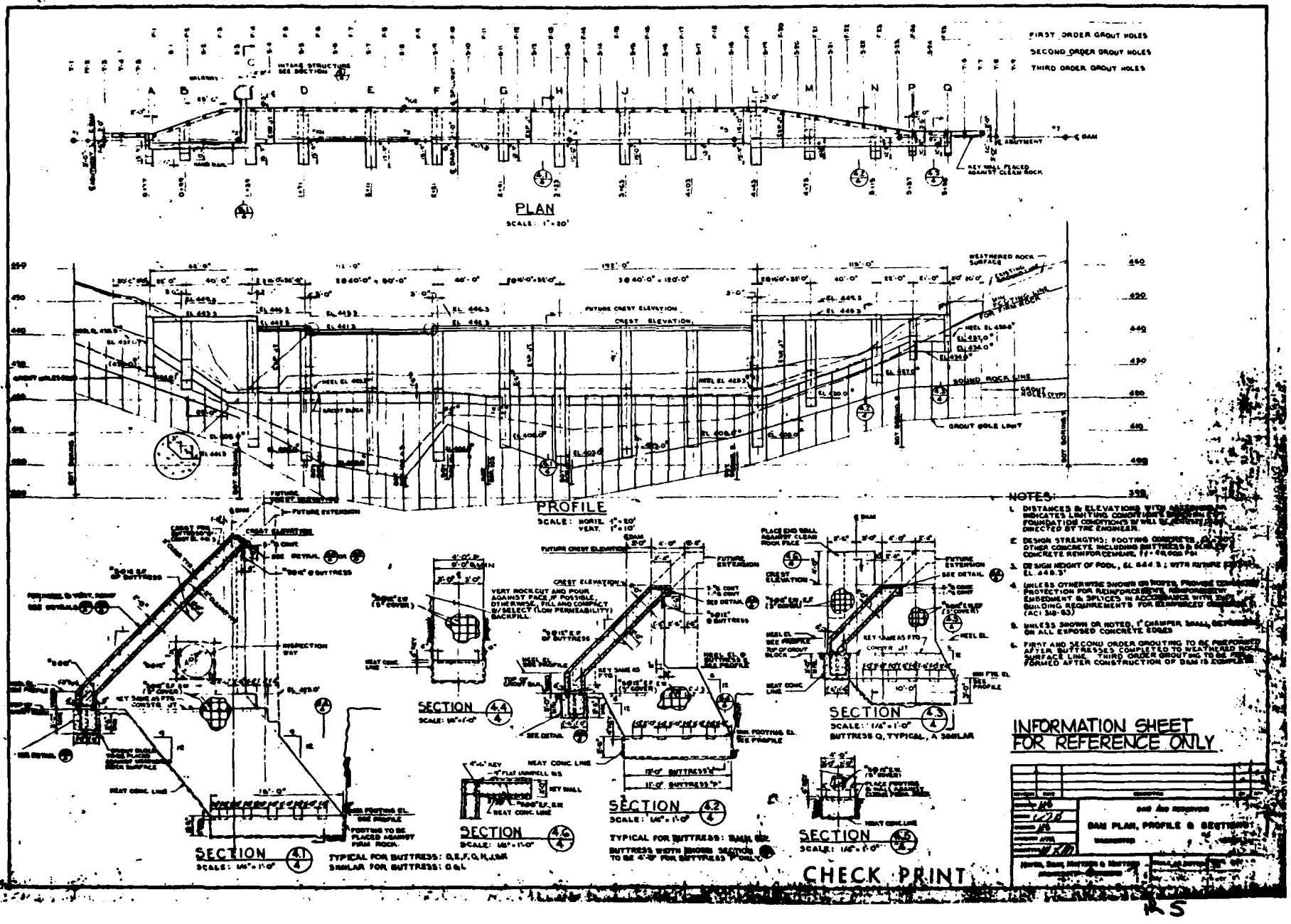


R1









APPENDIX II

PHOTOGRAPHS

PHOTO #1 DAM

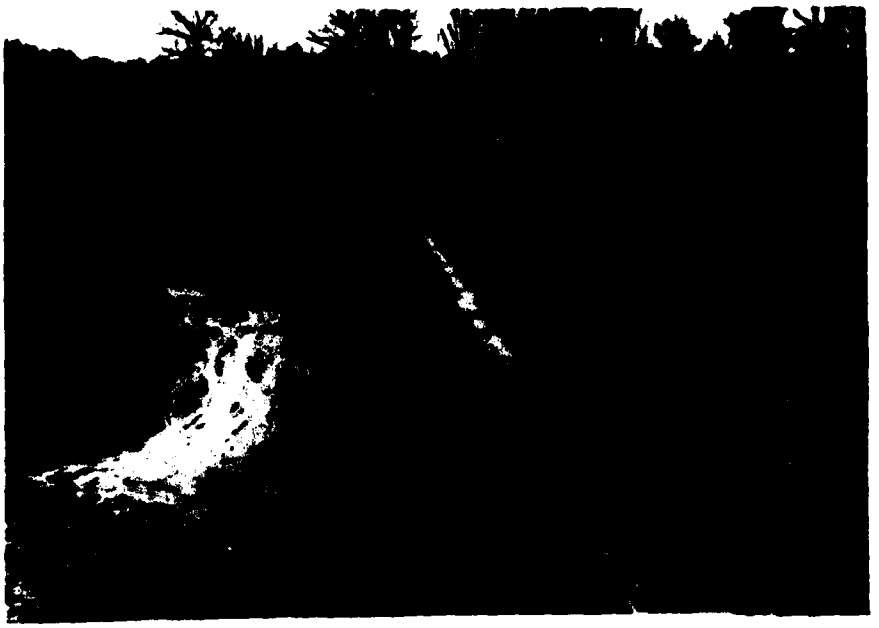


PHOTO #2 CREST OF DAM

PHOTO #3 ACCESS TO INTAKE STRUCTURE

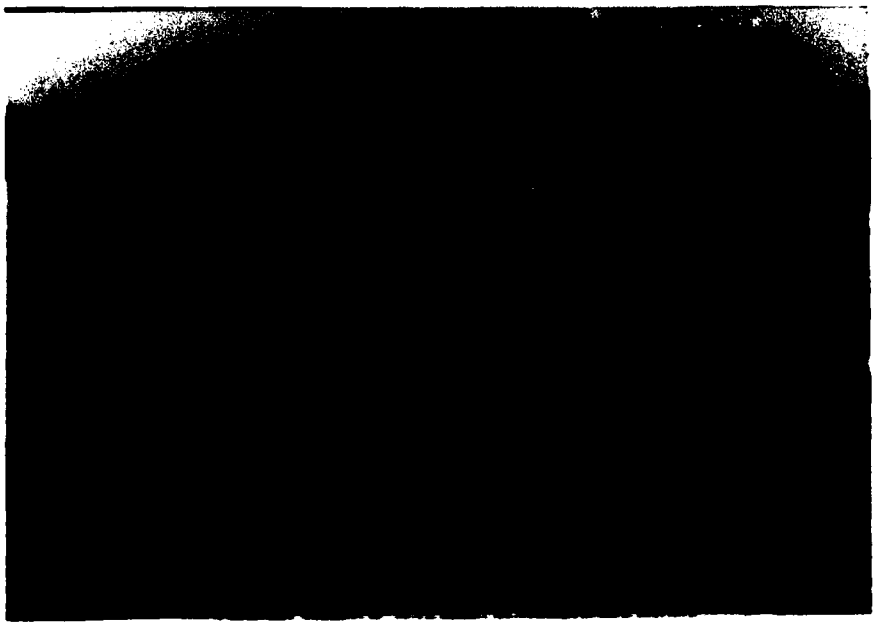


PHOTO #4 INTAKE STRUCTURE

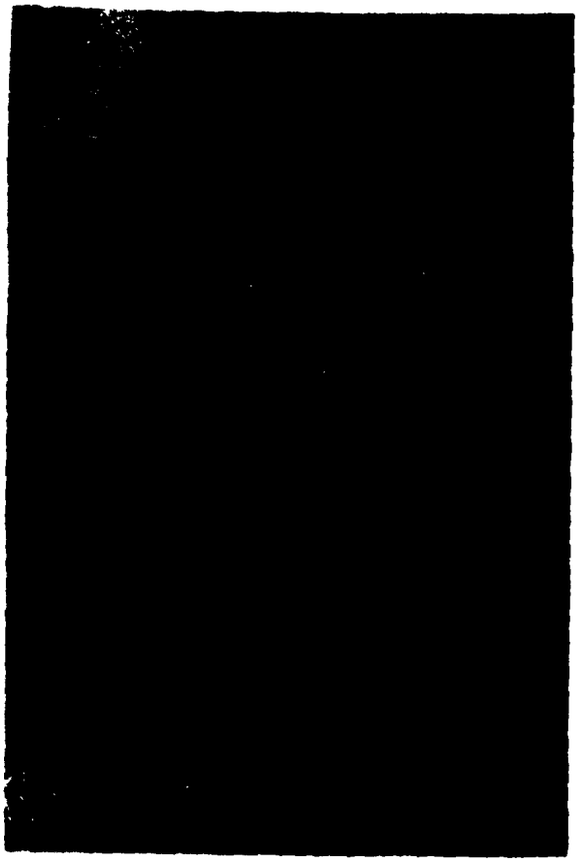


PHOTO #5 LEAK AT CONTACT OF SLAB AND RT. STRUCTURAL ABUTMENT

PHOTO #6 LEAKS THROUGH JOINT BETWEEN BUTTRESSES G AND H (estimated at 7-10 gpm)

PHOTO #7 DIKE (LARGER)

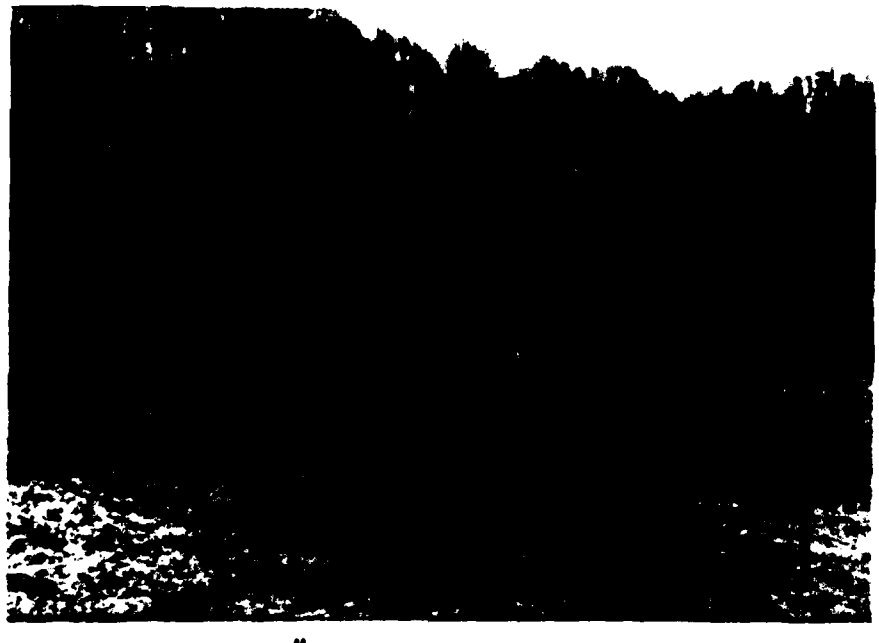


PHOTO #8 DIKE (SMALLER)

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam: Warrenton Dam County: Fauquier State: Virginia Coordinates: Lat. 3844.5
Long. 7747.4

Date Inspection: 18 Mar 1981 Weather: Snow Flurries Temperature: 30° - 35° F

Pool Elevation at Time of Inspection: 445 ft. msl Tailwater at Time of Inspection: 422± ft. msl

Inspection Personnel:

*J. Swean, COE	B. Taran, COE	E. Constantine, SWCB
M. Stith, COE	L. Jones, COE	Dr. A. Afejuku, SWCB
*D. Pezza, COE	*J. Robinson, COE	**Mr. J. Micheal O'Bryant, Town of Warrenton

*Recorders

** Not present during actual field inspection, but present during pre-inspection meeting.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEEPAGE/LEAKAGE	Buttress A: Water is dripping from cracks and the area below cracks is wet. Buttress C, D, F: Slab/buttress contact is wet where the dam crest has been raised. Expansion Jt. Slab C-D: EJ is slightly damp but not dripping. Expansion Jt. Slab G-H: EJ is leaking at 3-5 gpm. Slab K-L: Seepage is dripping along the contact of the old crest where the crest. was raised.	
STRUCTURE TO ABUTMENT/EMBANKMENT	No unsafe conditions were observed.	None.
DRAINS	N/A	
WATER PASSAGES	See Spillway III-6.	
FOUNDATION	Rock outcrops in the dam area consist of diabase, gneiss, and mica shist. Overburden in the area consisted of a red silty fine sand foam. The left and right abutments show no deterioration or erosion. There is slight to no weathering of exposed rock. There is a small spring in the right abutment approximately 20 ft. downstream. Flow is visually estimated to be less than 1 GPM. There is small leakage through and around the cutoff wall.	The leakeage through and around the cutoff walls, and the spring are not expected to effect the integrity of the dam. Flow from the spring should be monitored after lengthy periods of rain and when the reservoir is at different levels. This should aid in determining if the reservoir is contributing flow to the spring.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKES CONCRETE SURFACES	Some minor surface cracking was observed at slabs L-M, M-N, N-P. Cracking was somewhat obscured by a finish applied to the concrete surface. Finish looked like a paint or cement paste wash.	
STRUCTURAL CRACKING	Buttress A: Cracks originate at the underside of the thickened edge of the original dam crest and buttress junction. Cracks extend approximately 2'-6" down the buttress parrallel to the slab face. (Drawings furnished show a different precast panel detail than that observed in the field). Slab L-M: A 2'-0"± long vertical crack is located at the slab centerline extending down from the old crest of the dam. No seepage is occuring at the crack.	
VERTICAL AND HORIZONTAL ALIGNMENT	No sign of movement or unsafe conditions were noted.	
MONOLITH JOINTS (VERTICAL)	None visible.	
CONSTRUCTION JOINTS	Some minor leaking was observed at the contact between the old crest and new crest. Seepage is minor and may heal with time.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	There are cracks on the crest of both dikes. However, the cracks are less than an inch deep and are due to frozen conditions.	None.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	None
SLOUGHING OR EROSION OF DIKES AND ABUTMENT SLOPES	None	None
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Alignments do not deviate from the drawings.	None
RIPRAP FAILURES	There are no riprap failures. The upstream slopes of each dikes are protected with a diabase stone up to two feet in size. Abutment contacts are not riprapped.	The riprap should be extended to protect the abutment contacts from erosions due to runoff and/or wave action.

DIKES

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FOUNDATION	The foundation appears stable. There are no rock outcrops in the immediate area.	None
ANY NOTICEABLE SEEPAGE	There is no seepage. The downstream area had several frozen puddles. However, the standing water was attributed to runoff from a storm two days prior.	None
DRAINS	There are no foundation drain pipes. The drawings indicate the 300 ft. dike has a toe drain. The last five feet of the downstream slope of the dike is covered with crushed stone up to 1.5 inches in size.	None
MATERIALS	The dam is in the piedmont region and area soils are generally residual. The embankments appear to be comprised of low plastic sandy silts.	None
VEGETATION	The dikes were vegetated with grass during recent construction. Certain areas are sparse.	Dikes will need to be reseeded in the spring.

OUTLET WORKS
(WATER SUPPLY INTAKE)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONTROL SECTIONS	Three 8-inch gates at different elevations in the concrete intake structure are available to pass water into Cedar Run that supplies the Warrenton Filtration Plant.	None.
INTAKE STRUCTURE	The intake structure is submerged for most of its height and could not be closely examined. The intake structure that could be observed appears to be in excellent condition.	None.
DISCHARGE CHANNEL	A 24-inch outlet running from the intake structure allows flows into Cedar Run. The discharge is submerged. Riprap is placed around the plunge pool.	None.
BRIDGE STRUCTURE TO STRUCTURE	No unsafe conditions were noted on the reinforced concrete bridge.	None
EMERGENCY GATE	A 24-inch low level gate in the intake structure is available for drawing down the reservoir.	None
GATES AND OPERATION EQUIPMENT	The three 8-inch gates in the intake structure furnish water to the filtration plant 2 miles below the dam. Utilities personnel operate and maintain the gates as needed.	None

SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATION
CONTROL SECTIONS	The concrete weir allows a vertical discharge along the entire length. The weir is comprised of levels: 74 feet in length at elevation 445.3 224 feet in length at elevation 446.3 and 187 feet in length at elevation 449.3 plus 40 feet of concrete abutment. The concrete is not even nor level but appears in good condition.	None
APPROACH CHANNEL	The approach channel is the reservoir.	None.
DISCHARGE CHANNEL	The discharge channel is the area immediately below the weir overflow. The ground is soft and no apparent channel has been formed. The area generally slants to Cedar Run which is located near the right side of the dam.	None.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	There are no known monuments.	None.
OBSERVATION WELLS	There are no wells.	None.
WEIRS	There are no weirs.	None.
PIEZOMETERS	There are no piezometers.	None.
STAFFGAGES	There are no staffgages.	A staffgage should be installed to extend above the top of the dam to measure reservoir levels above normal pool.
OTHER	None.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir area slopes are gentle with grass pastures and wooded areas observed from the dam. No erosion around the reservoir was observed. There is little development in the watershed.	None
SEDIMENTATION	The inspection team was not able to evaluate sedimentation in the reservoir.	None

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS), DEBRIS, ETC.)	The downstream channel (Cedar Run) for the spillway is riprapped and in fair condition with little debris. The flow over the weir is not channeled but will flow to Cedar Run at right side of the dam.	None
SLOPES	The downstream area is sloped gently and wooded. The area is not developed except for a gravel road and bridge crossing the Cedar Run about 400 feet below the dam.	None
APPROXIMATE NO. OF HOMES AND POPULATION	One home is located below the earthen dikes but above the flood plain below the concrete spillway. The water filtration plant for Warrenton is located 2 miles below the dam.	None

APPENDIX IV

REFERENCES

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Office of the Chief of Engineers, Department of the Army, Washington, D. C.

2. HEC-1DB Flood Hydrograph Package, (Hydrologic Engineering Center, U. S. Army Corps of Engineers, September 1978.)

3. "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 51, (U. S. Weather Bureau, June 1978).

4. "Rainfall Frequency Atlas of the Unites States", Technical Paper No. 40, (U.S. Weather Bureau, May 1961).

5. "Design of Small Dams", Technical Publication of United States Department of the Interior, Bureau of Reclamation, Second Edition, Revised Reprint, 1977.


DA
FILM